

Monitoring of Heavy Metal Content in Leafy Vegetables Irrigated with Different Water Sources

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Abstract— The present research was conducted to calculate levels of different heavy metals like Fe, Mn, Cu, and Zn in leafy vegetables when grown with different water sources. The result showed quite high range of accumulation when the vegetables were irrigated with wastewater. Wastewater irrigated vegetables showed variations (115-377), (12-68), (5.2-16.8), (21-45) mg/kg for iron, manganese, copper and zinc. Highest toxic level of iron and manganese were detected in mint and spinach and carrot showed highest value of copper and zinc. From the present study we can conclude that the vegetables grown from these water resources will lead to heavy metal accumulation in human body i.e for both adult and children if they continuously consume these vegetables. For this regular monitoring of these heavy metals is needed in order to prevent excessive metal accumulation in the body. However the results obtained from the present study shows that the ranges of heavy metal were below the permissible limits set by WHO/FAO.

Keywords— Heavy metals, vegetables, daily requirement, waste water effluent, human health.

I. INTRODUCTION

Due to easy availability of wastewater and scarcity of freshwater, it is mostly used for irrigation of vegetables¹. Waste irrigation is thought to make a considerable contribution to heavy wastewater. The metal content of the soil are very harmful due their non- biodegradable nature and they can easily get assemble indifferent parts of the body. These metals are harmful because they can easily dissolve in water. A small amount of these metals is harmful because there is no proper method to remove these metals from our body. Heavy metals find their use in many industrial applications and so there are widely spread. Due to this reason the available waste water have large unit of these heavy metals in them as which when indirectly used for irrigation severely effects human body². Excess amount of accumulation in agricultural land irrigated by wastewater affects the food quality. The metal requirement in our body is obtained from the food and water that we consume and this in turn directly exposes us from the entry of toxic heavy

metals. Vegetables are an important ingredient of human diet that contains essentials nutrients like vitamins, minerals dietary fiber and antioxidants³. Leaves from different plant species such as perennial, annuals are consumed especially in rural areas, and there has been an increased trend of the consumption among the persons living in metro cities. Vegetables which have leaves as edible part are an economic source to ensure the micronutrient intake. Examples include Cabbage, Cauliflower, Broccoli, Lettuce, Coriander, Spinach and Turnip. Rapid industrialization and the use of natural resources have increased the accumulation of toxic substances like heavy metals in the soil. The required protein and vitamin which are supplied by vegetables are best to act against rough digestion and prevents constipation are supplied by vegetables⁴. The current research work was conducted with a view to calculate the amount of heavy metals that enter in our body through the agricultural practices that involves the use of wastewater irrigation. The various disadvantage of using wastewater was noticed and

daily intake of heavy metals were calculated with regard to different section of society⁵.

II. MATERIALS AND METHODS

2.1. Area of research and analysis

All the experimental findings were conducted in the Environmental science department of SHUATS, Allahabad. Leafy vegetables included in the research were radish, spinach, turnip, cauliflower, mint, coriander, and carrot were collected from three different selected areas in Allahabad. For the purpose of metal analysis edible parts of the plant were taken.

2.2. Preparation of samples

To remove harmful chemicals from the different vegetable samples double distilled water was used. Water content from the edible parts of the plant was removed by weighing the plant sample and then air-drying it. Vegetable samples were dried in oven at 70 °C- 80 °C for 24 hrs to remove moisture from it. Dry vegetable samples were crushed with mortar and pestle and filtered through cotton fabric.

2.2.1. Digestion of the vegetable samples

From different irrigation method three powder samples weighing 0.5 g was prepared for each leafy vegetables and three replicates were made. Crushing of ash was done with the help of per chloric acid and HNO₃ which was in the ratio 1:4. The sample was left to cool down and it was then filtered using Whatman filtrate paper No 42. A final volume of solution was made with 25 ml of distilled water and was sent for Atomic absorption spectrophotometry.

2.3. Standards

Standard solution used (1000 mg/l) (Merck, Germany). Different concentration solution for various metals were also prepared.

2.4. Data analysis

The daily intake of metals (DIM) was determined by the following formula:

$$DIM = \frac{M * K * I}{W}$$

DIM = M.K.I and W represent the heavy metal concentration found in plants (mg/kg), conversion factor, daily intake of vegetables and average body weight respectively. The conversion factor used to convert fresh green vegetables weight to dry weight was 0.085.

As investigated we have found the following facts average adult body weight for adult was 55.9 kg and child body

weight was found to be 32.7 kg. Average daily vegetable intakes for Adults was 0.345 kg/day and for children daily vegetable requirement was 0.0232 kg/ day⁶.

2.5 Statistical Analysis

All data are presented in terms of the means and standard triplicate error. Observations on heavy metal concentrations in response to different sources of irrigation were evaluated for the significance of the different using the t- test.

III. RESULTS AND DISCUSSION

A. Metal accumulation in plants

When any form of wastewater is added to the soil it changes the physical and chemical properties of the soil. We all know that heavy metals intake by the vegetables are not only affecting the soil profile but also causing serious health issues. Heavy metal contamination was much higher than freshwater irrigated vegetable samples. The concentration was in the ascending order starting with copper, zinc, manganese and iron in spinach, cauliflower, mint and coriander. In radish, turnip and carrot it was Fe>Zn>Mn>Cu. The heavy metal concentration for different vegetables irrigated with wastewater is shown in Table 1. Due to scarcity of fresh water most of the vegetable samples indicated the use of wastewater for irrigation¹. Minimum heavy metal accumulation was seen in freshwater Table 3 and unknown source of water Figure 1 as compared to wastewater irrigation. The observed differences may also depend on the different properties of soil⁷. Maximum accumulation of Manganese was in spinach (44-68 mg/kg) and carrot showed maximum concentration of copper. All the leafy vegetables have lower values of Zn and Cu as compared to maximum acceptable limit (61 mg/kg and 41 mg/kg). Following result was also reported by⁸. When a large quantities of these heavy metals get accumulate in the soil and plants they result in various health issues in human being⁹.

B. Daily requirement of metals (DIM)

To understand the intake of metals we need to understand the amount of exposure a certain heavy metal is causing by knowing its route into human body. Food chain is the easiest route for heavy metals to enter into our body. We all know that certain amount of minerals are essential for our metabolic activity but when the metals accumulate in larger quantity, they can result in health issues. Table 2 and 3 shows the daily consumption of metals from the selected vegetables for both adult and children. Waste water Table 2

and Figure 2 showed maximum DIM values for heavy metals as compared to fresh water. Following study results that consumption of vegetables grown from wastewater is

high compared to other water treatment but still the values are under recommended limits (WHO)

Table 1 Heavy metal content in plants grown in wastewater irrigated soil.

Plants	Zn		Cu		Fe		Mn	
	A	C	A	C	A	C	A	C
Radish	0.011	0.0013	0.0031	0.0035	0.0612	0.06	0.0066	0.0076
Spinach	0.016	0.01	0.0086	0.01	0.162	0.185	0.0365	0.0418
Turnip	0.014	0.017	0.0084	0.0096	0.1032	0.118	0.0095	0.01
Cauliflower	0.02	0.023	0.0026	0.0031	0.0027	0.12	0.0216	0.0248
Mint	0.023	0.026	0.0066	0.0076	0.1984	0.227	0.0353	0.0403
Coriander	0.016	0.018	0.0064	0.0074	0.1643	0.189	0.024	0.0264
Carrot	0.023	0.027	0.0087	0.01	0.1132	0.12	0.009	0.0104

Table 2 Daily consumption of heavy metals in wastewater source of irrigation

A-ADULT C-CHILDREN

Plants	Zn		Cu		Fe		Mn	
	A	C	A	C	A	C	A	C
Radish	0.012	0.013	0.003	0.003	0.06	0.069	0.0063	0.0072
Spinach	0.017	0.015	0.004	0.004	0.158	0.0181	0.0266	0.0306
Turnip	0.015	0.016	0.005	0.006	0.096	0.11	0.0082	0.0094
Cauliflower	0.019	0.022	0.002	0.002	0.077	0.089	0.0135	0.0155
Mint	0.023	0.027	0.008	0.009	0.189	0.217	0.0236	0.0271
Coriander	0.014	0.017	0.006	0.006	0.158	0.182	0.0198	0.0228
Carrot	0.024	0.027	0.008	0.01	0.097	0.112	0.0083	0.0096

Table 3 Daily consumption of heavy metals in freshwater source of irrigation

A-ADULT C-CHILDREN

Plants	Fe	Zn	Mn	Cu
Radish	111–122	21.1–24.3	10.0–17.0	5.21–6.42
	117 ± 5.4	22.5 ± 1.6	12.8 ± 3.7	5.96 ± 0.7
Spinach	279–333	31.2–34.9	64.3–73.8	15.9–17.4
	309 ± 27.0	33.1 ± 1.9	69.4 ± 4.8	16.5 ± 0.8
Turnip	176–212.4	28.8–30.3	11.8–23.3	12.4–20.1
	197 ± 19	29.3 ± 0.8	18.2 ± 5.9	16.1 ± 3.9

Cauliflower	198–232	38.2–41.8	33.5–47.5	4.8–5.5
	215 ± 17.0	40.2 ± 1.9	41.3 ± 7.2	5.23 ± 0.4
Mint	335–412	41.4–47.4	61.0–70.8	11.8–14.1
	378 ± 39.0	45.0 ± 3.2	67.0 ± 5.2	12.7 ± 1.2
Coriander	292–326	29.8–32.8	41.4–47.6	10.9–12.7
	313 ± 18.0	30.9 ± 1.6	43.9 ± 3.2	12.1 ± 1.0
Carrot	200–235	40.4–50.7	14.0–20.4	12.5–21.6
	216 ± 18.0	46.4 ± 5.3	17.4 ± 3.2	16.8 ± 4.6

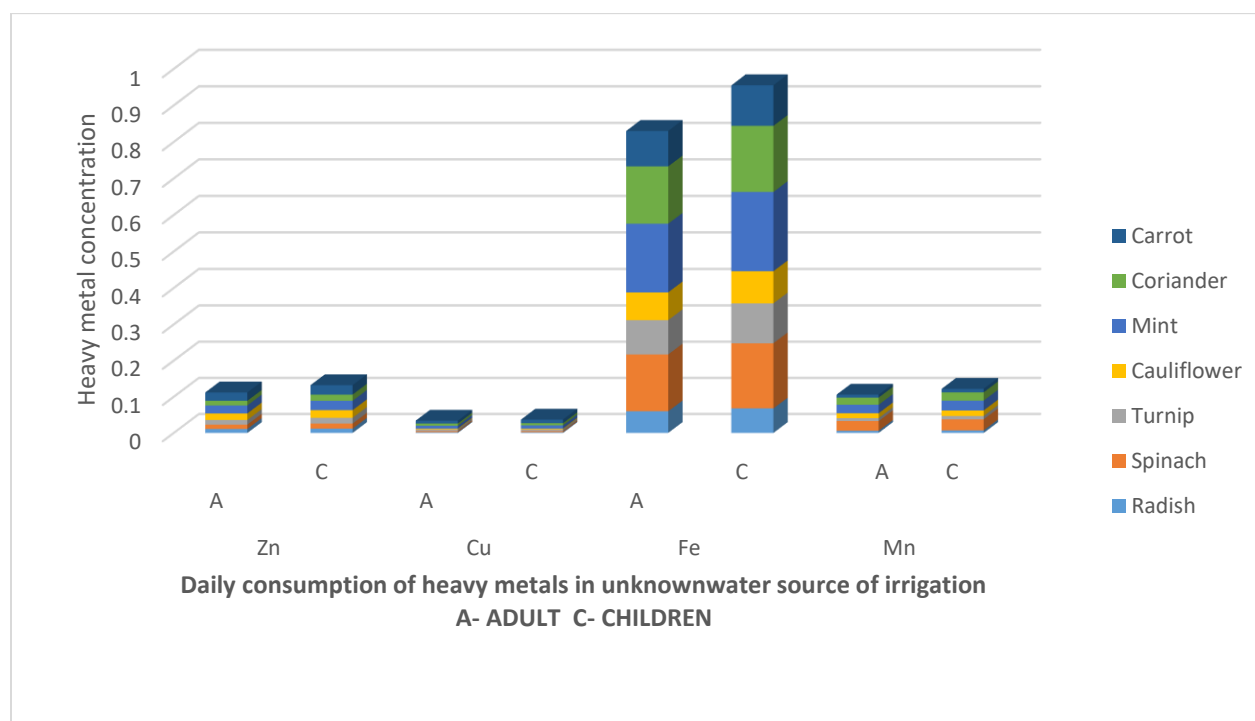


Fig.1: Daily consumption of heavy metals(mg) in unknown water source of irrigation

A- ADULT C- CHILDREN

IV. CONCLUSION

The main source of wastewater contamination are human and animal waste. Presence of phosphorus and nitrogen has also resulted in eutrophication of water resources and also has resulted in high amount of heavy metals in soil and vegetation resulting in potential health hazards. From the present study we conclude that heavy metals showed higher presence in waste water mode of irrigation. This study may also help other researchers to study different affected areas of Allahabad. Heavy metals showed their presence because of wastewater irrigation system practiced in the selected

areas. Heavy metals showed their presence could be due to following reasons i.e agricultural practices, geographic position and ability of the plant to absorb heavy metals. Suggested measure may include regular examination of heavy metals in all the food commodities grown in and out. Daily consumption of food results in long term low level body accumulation of heavy metals, with negative impacts only after certain time interval of metal exposure. Therefore, regular inspection of these heavy metals from different water sources, leafy vegetables and other daily intake is necessary to their entry in our food chain.

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